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High Speed Imaging Of Rayleigh-Taylor Instabilities in Laser Driven Plates[1]

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We have previously reported our observations of the dynamic behavior of laser drive plates[2,3]. Recent improvements and modifications of the imaging techniques have identifie and provided measurements of Rayleigh-Taylor (R-T) instabilities that occur in these events The microscope system in the LLNL Micro Detonics Facility, was converted to an epi-illuminated polarization configuration. A double pulse nanosecond illuminator and a seconc independently focusable frame camera were also added to the system.

A laser driven plate, that is a dense solid driven by a laser heated, lower density plasma, is inherently R-T unstable. The characteristics and growth of the instability determin whether or not the plate remains intact. In earlier reports we correlated the surface patternin of thin plates with the fiber-optical transmission modes. In subsequent experiments we note that the plasma burn through patterning in thin plates and the surface patterning of thicker plates did not correspond to the thin plate early time patterning. These observations led to tl suspicion of R-T instability. A series of experiments correlating plate thickness and pattern spatial frequency has verified the instability.

The plates are aluminum, deposited on the ends of optical fibers. They are launched by a YAG Laser pulse traveling down the fiber. Plate velocities are several kilometers per second and characteristic dimensions of the instabilities are a few to tens of microns. Sever techniques were used to examine the plates, the most successful being specularly reflectin polarization microscopy looking directly at the plate as it flies toward the camera. These images gave data on the spatial frequencies of the instabilities but could not give the amplitudes.

To measure the amplitude of the instability a semi-transparent witness plate was placed a known distance from the plate. As above, the plate was observed using the

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[2] Frank,A.M . & Trott,W.M. “Stop Motion Photography of Laser Driven Plates’, SPIE Vol 2273 , July 1994.

[3] Frank,A.M. & Trott,W.M. APS Shock Compression of Condensed Matter, Seattle, 1995.

polarization microscope but using the streak camera as the detector. Both the launch of the plate and its impact into the witness plate are observed on the streak record. Knowing the plate velocity function from earlier velocimetry measurements and observing the variations i the arrival time across the plate, the amplitude of the instability can be calculated.

Key Words
High Speed Microscopy, Rayleigh-Taylor Instabilities, Laser Driven Plates